Reply to RC1:

Thank you very much for the detailed comments, which are very much appreciated. Please find our answers below:

Regarding the size of the Figures: They will be larger in the final article.

- Line 39: "abundance" -> "properties" : corrected
- Line 66: "Does this mean that RTS cannot enable differential phase measurements?" -> No, but its not part of this study since it has been previously treated. The following sentence was added: Although differential phase measurements can also be performed with the instrument, as described in Schvartzman et al. (2024), this feature is not part of the current study
- Line 84: "From the text I aasume the Doppler shift is applied to the pulse frequency. Is RTS capable changing phase from pulse to pulse since that is how weather radars measure radial velocity. Can you please elaborate on this." -> We simply change the frequency of the transmitted pulses, such that the difference between the transmitted and the received frequency corresponds to the frequency change induced by the movement of the target. RTS is capable of changing the phase of the transmitted pulses, but not on a pulse-to-pulse basis. For the RTS it does not matter how the weather radar measures the Doppler frequency. We just need to generate a target that exhibits a certain Doppler shift.
- Line 95: Corrected to "...hence this assumption is valid."
- Line 104: Corrected to "...the approximation for the pulse volume given in eq. (6)"
- Figure 3: "If this is TX, should the arrow point as signal coming out?" and "If this is RX, should the arrow point as signal coming in?" -> No. The arrow describes the signal path from the digital side of the RTS towards the antenna. Likewise, the RX points from the antenna towards the digital part of the RTS.
- Line 234: "Maybe add an intrductory paragraph here." -> We have added a small introduction.
- Line 264: Corrected to "... repeated on a later day..."
- Line 294: Corrected to "are therefore detailed as follows."
- Line 307: Corrected to "...was obtained, which amount to a difference of 0.25 dB between the two methods"
- Table 3: "Typically, Zdr is the ratio Ph/Pv, while Z_DR = 10*log10(Zdr). So you might put 'DR' in the subscript instead of 'dr'" -> I have found a significant number of articles in the scientific literature that use Zdr to denote the logarithmic Ph/Pv ratio. We therefore think that we have used a suitable designation, which, in my point of view, is visually more appealing than ZDR.
- Line 357: " Fig. 1 shows the matched filter characteristics? Please provide more explanations." -> In Section 2 we explain Figure 1 as follows: "A point target, when detected using a perfectly rectangular pulse, produces a parabolic response curve after matched filtering, similar to a triangular response in the voltage domain with a base width twice the pulse width. Since the radar’s range resolution corresponds to the pulse width, there is a high probability that a point target will be sampled away from its peak response. This issue is mitigated by adjusting the target’s range while maintaining its radar reflectivity. This

matched filter effect is illustrated in fig. 1 where data from the StXPol radar (see section 4) has been used. A static target was generated at various distances from the radar while its reflectivity was kept constant at all positions. The target's normalized amplitude in the voltage domain as detected by the radar is plotted as a function of the target range. By applying a triangular least-square fitting procedure on the measured data and evaluating the width of the fitted triangle at half of its maximum, the width of the matched filter can be experimentally inferred." -> We consider this a relatively detailed explanation and could provide the mathematical details of the convolution, which is not too exciting for a rectangular pulse.

- Line 365: Corrected to " with the differential reflectivity of the target set to 0 dB.
- Figure 10: "Time series typically denote IQ samples. Maybe say "individual measurements" instead." -> In my opinion, time series can denote all kinds of data.
- Line 377: Corrected to "... differential reflectivity value of Zdr = 0 dB was used"
- Line 379: Corrected to "However, given that the effects of polarization channel coupling on the Zdr bias was investigated in..."
- Line 383: Corrected to "... channel and was collected in April..."
- Line 385: Corrected to " can be observed. We conjecture that the number of scan repetitions is insufficient..."
- Line 386: "If the target is generated by the RTS, and it is unstable then this the problem with the RTS. Please clarify. Also, the difference of 0.15 dB is not insignificant." -> With "variance of the target properties" we mean the fact that the generated target Zdr was not set to a fixed value but varied from -4 dB to 4 dB, which is a considerable range compared to the bias of 0.15 dB. Varying a target involves phase changes that might affect the differential reflectivity. Such measurements are not comparable to a test session where the target is fixed to a certain value over a long time. Given the data basis that consists of a wide Zdr range, we think that a bias 0.15 dB is indeed not significant.
- Line 392: "No sure what you mean by "manifold" here. Please clarify." -> Sentence changed to "Many advantages are associated with generated targets that exhibit specific Doppler properties"
- Line 394: "What is "staring mode"? Please explain." -> Rephrased to "The radar pointed directly towards the RTS without moving its antenna (i.e., staring mode)"
- Line 420: Corrected to "narrow beam width of 0.3° facilitate the identification..."
- Line 438: Corrected to "time series were compiled from..."
- Line 440: Corrected to "fitted curves were used to produce the plot"
- Line 445: "Have you considered the effects of the active electronics in the Tx and Rx paths?" -> Just from our data, we are unable to identify to origin of the biases. Active electronics are certainly a potential source of errors. On the other hand, CHILL is a very well calibrated radar. We have therefore focused our investigation on the experimental setup and concluded that the elevation resolution is not sufficient for such a narrow antenna beamwidth.
- Line 480: "Did you measure cross-polar radiation patterns to speculate this? It seems that you did not. I would be more inclined to say that the difference is due to the different active and passive electronics in the two radars ..." We did not measure cross polar radiation and have added a more detailed discussion on this, since this was also requested by reviewer 2.
- Line 481: Corrected to "StXPOL antenna, as depicted in ..."

- Line 494: fig. comes from the definition in \cref. If wrong than it will be corrected in the final paper.
- Line 505: Corrected to "reflectors, RTS facilitates the generation..."

Reply to RC2:

We appreciate the comments of reviewer 2. With respect to his or her comments, please find our answers below:

RC2: "However, the authors present these features with a word of caution."

Yes. Since some of the authors are also the cofounders of the company that develops the radar target simulator, we need to be careful to not misuse the article in AMT as a platform to advertise our product. We try to focus on proven evidence obtained with a series of state-of-the-art weather radars and leave the judgement on the suitability of the RTS features to the readers of the article. We do not try to sell anything here but intend to present a calibration technology that has not been described in detail in the scientific literature.

RC2: "The results are interesting for absolute calibration, but differential calibration should be better discussed."

We have taken into account previous work that has been performed on differential power measurements of the sun in view of obtaining information on the co- and cross-polar characteristics of the antenna. We have expanded the introduction that now explicitly mentions that solar measurements are an integral part of many differential reflectivity calibration procedures and that also other procedures (i.e., bird-bath scans) exist since decades that are employed for operational calibration of the Zdr bias. We try to highlight the additional measurement capabilities of the RTS with respect to differential reflectivity, such as calibrations at non-zero target values and investigations of the Zdr dependence on the differential phase.

Although we do not have solar box scans at hand, we try to discuss the usefulness of additional co- and cross-polar measurements of the antenna, as inferred from the sun or from other sources. We totally agree that such data would be very helpful for the interpretation of the different Zdr patterns and we suggest to measure such data in upcoming experiments. In fact, it would be relatively easy to do so with the RTS system itself. For the time being, the interpretation of the Zdr measurements remains speculative, which is clearly indicated in the manuscript.

RC2: " I suggest revising the structure of the paper. In particular, consider a different order for sections 2 and 3. Section 3 seems to illustrate a general theory but is actually described with specific reference to RTS, which is described later in section 3."

We agree and have therefore restructured the manuscript. The second part of Section 2 has been moved to Section three, since it is more related to the actual instrument rather than to the more general description of the RTS theory.